REMARKS

Claims 1-58 are pending in the application, with claims 1-58 having been rejected. Further examination and reconsideration respectfully are requested.

Examiner's Acceptance of the Drawings

The examiner's review and acceptance of the drawings filed on June 20, 2003 is noted with appreciation.

Status of Examiner's Consideration of Applicants' Information Disclosure Statements

The examiner's acknowledgement of the Information Disclosure Statements filed on November 24, 2003 and December 11, 2003 is noted with appreciation.

Independent claims 1, 9 and 51 and Claims Dependent Therefrom Are Not Obvious Over Delong et al. in View of Okamoto et al.

Claims 1-58 stand rejected under 35 USC § 103 as being unpatentable over the article by Delong et al. entitled "A 1:1 electron stepper" in view of US Patent No. 5,280,221, issued January 18, 1994 to Okamoto et al. Of these claims, independent claims 1, 9 and 51 include a limitation directed in various ways to a reversed polarity of electrical potential across two electrodes. The rejection of independent claims 1, 9 and 51 and their dependent claims is traversed.

Independent claims 1, 9 and 51 include a limitation directed in various ways to a reversed polarity of electrical potential across two electrodes. An advantage of the invention as set forth in these independent claims and their dependent claims is described in the specification on page 3, lines 17-25, as follows.

> Generally, the present invention relates to approaches to increasing the lifetime of M-I-M planar electron emitters (PEEs). It is believed that one of the important mechanisms in limiting the lifetime of the PEE is related to the in-diffusion of metal ions from the thin metal anode of the PEE into the insulating layer. Once the metal ions diffuse through the thin insulator to

> the other metal layer, it becomes impossible to maintain an electric potential between the two metal layers, and so no electron beam can be generated.

This advantage is achieved in various approaches. One of the approaches which supports independent claims 1, 9 and 51, is summarized in the specification on page 3, line 29 through page 4, line 4, as follows.

> In the second approach, the electrical potential across the M-I-M PEE is occasionally reversed from the polarity used to generate the electron beam. This counteracts the electrical driving force that drives the positively charged metal ions from the PEE anode to the PEE cathode, thus increasing the length of time taken for the metal ions to diffuse across the insulator layer from the anode to the cathode.

In rejecting independent claims 1, 9, and 51 and the claims dependent therefrom, the examiner asserts that Delong et al. disclose a configuration wherein an insulating layer is disposed between a first and second electrically conducting layer, but acknowledges that Delong et al. fails to disclose a power supply providing an inverted polarity between the conducting layers. However, the examiner further asserts that Okamoto et al. discloses a source of electric potential connected to electrodes at a first half cycle of each cycle of an AC voltage so that at each half cycle, electrons are generated from electrons stored in the layer inside of the thin film, and emitted from the second electrode. The examiners then asserts that it would have been obvious to one having ordinary skill in the art at the time the invention was made to combine the methods and apparatus of Delong et al. and Okamoto et al. Applicants do not agree.

A *prima facie* case of obviousness requires that three basic criteria be established. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Third, the prior art reference (or references when combined) must teach or suggest all the claim limitations. The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be

found in the prior art, and not based on applicant's disclosure. *See* MPEP § 2142, Eighth Edition, Rev. 2, May 2004, page 2100-108. Moreover, a prior art reference must be considered in its entirety, which is to say as a whole, including portions that would lead away from the claimed invention. *See id.* § 2141.02, page 2100-125.

The examiner has failed to show that either Delong et al. or Okamoto et al. discloses any suggestion or motivation whatsoever to modify the Delong et al. reference or to combine their teachings. Granted, Okamoto et al. discloses an alternating AC voltage potential connected to opposing conducting layers, the polarity of the AC voltage being reversible. However, Okamoto et al. contains no suggestion whatsoever to modify Delong et al. because the materials between the conducting layers respectively have very different properties. The MIM cathode disclosed in Delong et al. has a single thin dielectric layer of Al_2O_3 between the two conductors that enables electrons to move under the influence of a strong electric field. The cathode structure disclosed in Okamoto et al. has two layers between the conductors which operate to "bunch up" electrons at the interface between the layers to form a space charge region; *see, e.g.*, FIG. 2A (thin insulating film 3 and thin dielectric film 4) and FIGS. 3A and 3B. Because of the significantly different type of material used between the conductors of Delong et al. and Okamoto et al., one of ordinary skill would not find any suggestion in Okamoto et al. to apply its teachings to the Delong et al. device. A prior art reference must be considered in its entirety, and the suggestion to combine must come from the reference, not from applicants' disclosure. Nothing in Okamoto et al. suggests applying the voltage reversal of Okamoto et al. in isolation, without also applying the associated teachings as to the type of material between the conductors as well as the overall function of the device.

Sometimes a suggestion to modify can be found when a problem is in common with the references. However, the problems to be solved by Delong et al. and Okamoto et al. are not the same. Delong et al. reports on experiments conducted with a MIM cathode, and proposes in the conclusion section of their article that by using vacuum deposition techniques in lieu of oxidation processes, the lifetime of the MIM cathode may

be increased. The present invention in fact also relates to approaches to increase the lifetime of MIM planar electron emitters; *see* Present Application, page 3, lines 17-23. As described on page 3, lines 18-25, for example, diffusion of metal ions from the anode (element 208A in FIG. 2A) may be the mechanism which limits the useful lifetime of the planar electron emitter. The specification puts forth that positively charged metal ions from the anode diffusing into and through the insulator material (element 204A in FIG. 2A) may eventually reach the cathode (element 202A in FIG. 2A), thereby making it impossible to maintain an electrical potential between the two metal layers (i.e., the device is "shorted-out"), and hence no electron beam can be generated. In one aspect of the invention, reversing the polarity of the electrical potential, i.e. reverse biasing the device, returns the positively charged metal ions which have diffused into the insulating layer to the anode, thereby ameliorating the problem. In contrast, Okamoto et al. is not directed to increasing the lifetime of the Okamoto device. In Okamoto, the "reverse bias" portion of the reversible AC signal is designed to bunch electrons traveling in the "reverse direction" at the interface between the thin film (element 4, FIG. 2A) and insulator (element 3) to form a so-called space charge layer. Then, during the forward bias portion of the AC signal, the electrons in the space charge layer are accelerated in the opposite direction and emerge as hot electrons which ultimately interact with the phosphor layer (element 8, FIG. 2A) to generate a light output. Hence, Delong et al. and Okamoto et al. address no common problem and contain no other motivation to combine their teachings.

Since the examiner has not cited to any suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings, the rejection of independent claims 1, 9, and 51 over Delong et al. in view of Okamoto et al. must be withdrawn. All claims dependent from independent claims 1, 9 and 51 are allowable as well, since they include all of the limitations of the independent claims from which they depend and are patentable for the same reasons as set forth above.

While the dependent claims may recite additional limitations of independent patentable significance, extensive discussion of their independent patentability is moot in view of the remarks made in connection with the independent claims. Nonetheless, polarity reversal may be achieved asymmetrically, either in time or amplitude or both, and this aspect of the invention is set forth in various claims such as, for example, claims 2, 3, 13 and 14. In normal operation of the planar electron emitter, positively charged metal ions from the anode (element 208A in FIG. 2A) diffusing into and through the insulator material (element 204A in FIG. 2A) may eventually reach the cathode (element 202A in FIG. 2A), thereby making it impossible to maintain an electrical potential between the two metal layers (i.e., the device is "shorted-out") and hence no electron beam can be generated. However, reversing the polarity of the electrical potential returns the positively charged metal ions to the anode which have diffused into the insulating layer. The asymmetry in time or in voltage incorporates an engineering safety factor that the positively charged mobile ions will be returned to the anode. During the forward bias portion of the asymmetric signal, the electric fields generated within the insulator material (positive voltage applied to anode and negative to cathode) would apply a driving force on positively charged mobile ions in the insulator to be driven towards the cathode, an undesirable result if not counteracted. The time domain asymmetry is intended not just to counteract, but overcompensate with an appropriate margin of safety.

Okamato et al. discloses utilizing a symmetric alternating signal applied to the electrodes for an entirely different purpose, a purpose that is contradictory to a principal advantage of the present invention and has nothing to do with increasing the lifetime of the device. In Okamoto et al., the purpose of the "reverse bias" portion of the reversible AC signal is to bunch electrons traveling in the "reverse direction" at the interface between the thin film (element 4, FIG. 2A) and insulator (element 3) to form a so-called space charge layer. Then, during the forward bias portion of the AC signal, the electrons in the space charge layer are accelerated in the opposite direction and emerge as hot electrons which ultimately interact with the phosphor layer (element 8, FIG. 2A) to generate a light output. Disadvantageously, the effect of the space charge layer created

in the Okamato et al. device is to impede removal of the positively charged ions from the layer 3. For example, the electric field generated by the "bunched" electrons in the space charge region imparts a sufficient driving force on positively charged metal ions in the thin insulator 3 and on the near surface of the anode so as to increase the probability of "shorting out" the device and unintentionally limiting its lifetime. It would therefore not have been obvious to one having ordinary skill in the art at the time the invention was made to combine the methods and apparatus of Delong et al. and Okamoto et al. to increase the lifetime of their devices. Claims 2, 3, 13 and 14 would not be obvious for this additional reason.

Independent claims 16, 32, 41 and 58 and Claims Dependent Therefrom Are Not Obvious Over Delong et al. in View of Okamoto et al.

Claims 1-58 stand rejected under 35 USC § 103 as being unpatentable over the article by Delong et al. entitled "A 1:1 electron stepper" in view of US Patent No. 5,280,221, issued January 18, 1994 to Okamoto et al. Of these claims, independent claims 16, 32 and 41 include a limitation directed in various ways to temperature control of a planar electron emitter. Independent claim 58 includes a limitation directed to a planar electron emitter having a lifetime in excess of one million exposure shots of approximately 100 msec. The rejection of independent claims 16, 32 and 41 and their dependent claims, and of independent claim 58 is traversed.

Independent claims 16, 32 and 41 include a limitation directed in various ways to temperature control of a planar electron emitter, and independent claim 58 includes a limitation directed to a planar electron emitter having a specified lifetime characteristic. An advantage of the invention as set forth in these independent claims and their dependent claims is described in the specification on page 3, lines 17-25, as follows.

> Generally, the present invention relates to approaches to increasing the lifetime of M-I-M planar electron emitters (PEEs). It is believed that one of the important mechanisms in limiting the lifetime of the PEE is related to the in-diffusion of metal ions from the thin metal anode of the PEE into the insulating layer. Once the metal ions diffuse through the thin insulator to the other metal layer, it becomes impossible to maintain an electric

> potential between the two metal layers, and so no electron beam can be generated.
>
> The approaches of the present invention are directed to reducing the possibility that diffusion takes place and also to reversing the diffusion process.

This advantage is achieved in various approaches. One of the approaches which supports independent claims 16, 32, 41 and 58 is summarized in the specification on page 3, lines 26-28, as follows.

> Diffusion is a temperature dependent process; for the first approach cooling the PEE to temperatures below room temperature lowers the metal ion mobility, and so the metal ions are less likely to diffuse into the insulator layer.

In rejecting independent claims 16, 32, 41 and 58, and the claims dependent therefrom, the examiner asserts only that "It would have been obvious to one of ordinary skill in the art at the time of the invention was made to ... <u>add features like controlling temperature for cooling the planar electron emitter, because Delong et al. teach ... that a projection lithographic system imaging a mask of an integrated circuit in 1:1 ratio by means of photoemission of electrons, has indisputable advantages."</u> Office Action of May 19, 2004, page 4. Pursuant to MPEP § 2144.03, Eighth Edition, Rev. 2, May 2004, page 2100-138, applicants hereby traverse that adding features like controlling temperature for cooling the planar electron emitter is common knowledge or well-known in the art, and request the examiner to provide suitable documentary evidence in the next Office action if the rejection is to be maintained.

The Delong et al. and Okamoto et al. references themselves are strong evidence that cooling the planar electron emitter is not well known in the art. Okamoto et al. contains no teaching whatsoever regarding cooling of the planar electron emitter, even though it purports to achieve a long lifetime; *see* US Patent 5,280,221, column 2, line 28–31. Delong et al. is acutely aware of the desirability of a longer lifetime, and even proposes in the conclusion section of the article that by using vacuum deposition

techniques in lieu of oxidation processes, the lifetime of the MIM cathode may be increased. However, no mention whatsoever is made of cooling the device.

Moreover, the examiner has not explained why one of ordinary skill would even consider cooling the planar electron emitter. It is not normal practice to do so, and there is no reason evident from the applied references to do so, particularly in view of the additional cost and complexity. In contrast to the Delong et al. and Okamoto et al. references, the inventors of the present application understood the failure mechanism. As described on page 3, lines 18-25 of the specification, diffusion of metal ions from the anode (element 208A in FIG. 2A) may be the mechanism which limits the useful lifetime of the planar electron emitter. The invention puts forth that positively charged metal ions from the anode diffusing into and through the insulator material (element 204A in FIG. 2A) may eventually reach the cathode (element 202A in FIG. 2A), thereby making it impossible to maintain an electrical potential between the two metal layers (i.e., the device is "shorted-out"), and hence no electron beam can be generated. Having understood the problem, the inventors further understood, as described on page 3, lines 27-29, that cooling the planar electron emitter decreases the mobility of the charged ions, thereby reducing the probability that the ions will diffuse into and through the insulating layer thereby increasing the useful life of the planar electron emitter. The inventors also describes experimental data (see Page 19 line 12-19) on a prototype planar electron emitter that exhibits a thirty-to-forty fold increase in lifetime when cooled to liquid nitrogen temperatures (77 Degrees Kelvin). Given that uncooled planar electron emitters with no reverse biasing have demonstrated lifetimes of 30,000 to 40,000 exposure shots of 10 milliseconds each (page 21 line 10 – 14), this establishes that a lifetime of 1 million exposures is feasible for a commercial device.

Delong et al. and Okamoto et al. did not understand the failure mechanism, much less a solution for it. Delong et al. states in the conclusion section of their article that by using vacuum deposition techniques in lieu of oxidation processes, they may increase the lifetime of their MIM cathode. Okamato et al. states in column 2, lines 28-31 that "the cold cathode device structure of the present invention is small in fluctuation of emitted

electron current, and, therefore has a long life." Neither Delong et al. nor Okamato et al. were contemplating the failure mechanism of mobile ions diffusing from metal electrodes, and as such, were not contemplating and did not disclose techniques to cool their devices to prolong the useful lifetime.

Since neither of the references cited and applied by the examiner teach or suggest cooling the planar electron emitter, even though both are aware of lifetime considerations, the examiner assertion cannot stand. The examiner must be guided by Section 2144.03, page 2100-136, which provides that:

> It would not be appropriate for the examiner to take official notice of facts without citing a prior art reference where the facts asserted to be well known are not capable of instant and unquestionable demonstration as being well-known. For example, assertions of technical facts in the areas of esoteric technology or specific knowledge of the prior art must always be supported by citation to some reference work recognized

The rejection must be withdrawn.

Conclusion

In view of the foregoing amendments, it is believed that the application is now in condition for allowance. Applicants respectfully request favorable reconsideration and the timely issuance of a Notice of Allowance. If a telephone conference would be helpful in resolving any issues concerning this communication, please contact the undersigned at (952) 253-4135.

Respectfully submitted,

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Date: August 19, 2004

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